



Research article

A comparative study on microencapsulated essential oils for mosquito repellent finished cotton fabrics

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ABSTRACT

Mosquitoes are of leading public health concern because many species are vectors of diseases and they transmit parasites and pathogens, which continue to have an overwhelming impact on the human health. They are the main cause of spreading the deadly diseases like malaria, dengue, filariasis and chikungunya. A mosquito repellent textile is a textile product, which protects the human beings from the bite of mosquitoes and thereby promising safety from the mosquito borne diseases. To impart this character, a finish of the mosquito-repelling agent is given to the textile material. The main objective of the study was to develop an Eco friendly, efficient mosquito repellent finished fabric using essential oils; (Lemongrass, Thyme and Lavender). The essential oils were finished onto the cotton fabrics (Pure mercerised cotton fabric and Plain weave cotton fabric) by microencapsulation using pad dry cure method. Today's textile industry makes use of microencapsulated materials to enhance the properties of finished goods. The microcapsules binding on to the fabrics were confirmed by scanning electron microscopy analysis and the presence of chemical functional groups were confirmed by FTIR analysis. Thyme oil microcapsules treated fabric showed maximum antibacterial activity. The comparison between Microencapsulated oil finished cotton fabrics (pure mercerised cotton fabric and plain weave cotton fabric) were evaluated for mosquito repellency efficiency against *Aedes aegypti* using a Mosquito Repellency Behavioral test. Wash durability test for the finished fabrics will be evaluated by subjecting the finished fabric to 3 washes followed by repeating the Mosquito Repellency Behavioral test to check its efficiency.

Keywords: Mosquito repellent , FT IR, Textiles and *Aedes aegypti*.

INTRODUCTION

Recently, there has been a great interest in apparel industry all over the world for demanding functionality of textiles such as wrinkle resistance, soil release, and water repellency, flame retardant. A mosquito repellent textile is one such functional textile product came out recently. It protects the human beings from the bite of mosquitoes and thereby promising safety from the mosquito borne diseases (Anitha R *et al.*, 2011). Health and hygiene are the primary requirement for human beings to live comfortably and work with maximum efficiency. Thus to protect the mankind from pathogens and to avoid cross infection, a special finish like antimicrobial finish has been given to the fabric material using essential oils (Thilagavathy *et al.*, 2007).

Mosquitoes are members of the family of nematocid flies. In

particular, many species of female mosquitoes are blood-sucking pests and carriers of dangerous diseases like West Nile Virus disease; Malaria, Dengue Fever, Chikungunya, Zika virus disease, St. Louis encephalitis Lyme disease etc (Vigneshkumar Murugan *et al.*, 2012). Mosquito borne diseases are prevalent in more than 100 countries, infecting 300-500 million people and causing about 1 million deaths every year. In India, more than 40 million people suffer from mosquito diseases annually (Bhupen Kalita *et al.*, 2013). As far India is concern, the populations of mosquito are found to be enormous day by day. Dengue Hemorrhagic Fever and Dengue fever are the most common mosquito-borne viral diseases that affect a wide range of people in the world. It is caused due to the bite of an infected Aedes Mosquito. It is a threatening disease as there is no proper vaccine or treatment yet found (Patel E K *et al.*, 2012)

At present, controlling the mosquito is one of the utmost importances due to increase in number of mosquito borne illnesses. The most commonly used repellents are lotions, coils and liquidators which are limited in their function due to various reasons. This has necessitated the development of mosquito repellent textiles (Ramya K *et al.*, 2014). A mosquito repellent is a substance that are applied on human skin, clothing or other surfaces that prevent mosquitoes from sitting or crawling on that surface. There are of synthetic chemical origin and naturally available .Compound which possess repellency against mosquitoes Plant- derived repellents usually do not pose hazards of toxicity to humans and domestic animals and are easily biodegraded. Compared to synthetic compounds, which pose environmental threat, lethal effects on non-target organisms and also resistance of mosquitoes to insecticides have increased during the last five decades.

In this study essential oils like Lemongrass (*Cymbopogon citratus* or *Andropogon citratus*), Thyme (*Thymus vulgaris*) and Lavender oil (*Lavandula angustifolia*)oil are used which are well known for its medicinal properties, good antibacterial, antifungal and antiviral property.

Coating of oil gets easily oxidized, and is removed easily when exposed to sun light. This problem could be overcome by coating the fabrics with microencapsulated oil. The microencapsulated repellent released slowly by disturbing the coated fabric material because of microencapsulation. The present study is to develop an ecofriendly mosquito repellent and antibacterial fabric by treating them with natural essential oils like lemongrass, thyme and lavender individually .The application of repellent and antimicrobial finish was done by using microencapsulation technique [1].

MATERIALS AND METHODS

Collection of Samples

Essential oils such as Lemongrass, Thyme and Lavender oil were purchased from the organic shop. Fabric material -Pure mercerised cotton fabric and Plain weave cotton fabric were purchased from commercial textile shop and Mosquito eggs (*Aedes aegypti*) were collected from Entomology Research Institute, Loyola College, and Chennai.

Preparation of Microcapsules by Ionic Gelation Process

An equal proportion of sodium alginate and oil were prepared. To this, 3 ml of Tween 20, were added and mixed thoroughly to form smooth viscous dispersion. The mixture was sprayed into calcium chloride solution using a syringe and the droplets were retained in 10% calcium chloride for 15minutes. Then microcapsules were obtained by decantation and repeated washing with isopropyl alcohol followed by drying at 45 °C for 12 hours. The microcapsules were then used for finishing on the selected fabrics.

Fabric treatment by pad dry cure method

The fabrics were immersed for 30 minutes in the binder solution 8% Citric acid (8gms of citric acid in 100ml of distilled water).

After 30 minutes the microcapsules were padded on the fabric and dried at 80- 85 °C in the oven for 5 minutes and cured at 150 °C for 2 minutes.

Scanning electron microscopy analysis

The SEM analysis was mainly studied to identify the finished and unfinished molecules present in the fabric sample. The microcapsules finished samples were analyzed to confirm the binding of microcapsules and alignment on to the fabric samples tissues [2].

Types of Cord Blood Banks

Cord blood can be donated to a public cord blood bank for use by someone in need or stored at a family cord blood bank for baby's or family's use.

Public Cord Blood Banks

Public cord blood banks save and use cord blood for transplants for helping the people with kind of treatable diseases or for scientific research to learn more about the possible uses of the cord blood. Transplants done are anonymous and no information about the owner of the cord blood is given to the person receiving it. The cord blood that is donated becomes the property of the public cord blood bank. At this time, in the United State there is only one public cord blood bank available that accepts the cord blood donations from the babies born in Arizona. They are Cryo-banks International.

Family Cord Blood Banks

Using family cord blood banks, the family can control the use of the cord blood. According to the studies, there is less graft versus host disease complications and there are better survival rates when cord blood from a related source is transplanted. Yet, there is no guarantee that the saved cord blood will be able to be used in all situations.

Who Can Bank Cord Blood

Currently, only about 3% of parents now choose to save the cord blood. The reason for this is simple, cost. It costs approximately one lakh rupees for the initial umbilical blood draw followed by a yearly storage fee ranging from 5,000 to 10,000 rupees. Anyone with the financial means to afford this should consider it. The potential upside is almost limitless. There are claims that cord blood stem cells are a stepping stone to immortality. This is purely hype but it isn't completely false. The implications for ending disease by replacing cells are effectively removing the disease at its root.

Anyone can donate the cord blood from their childbirth at no cost. It is then put in a public cord blood bank that can be used by anyone. This is similar to an organ bank but much more effective as the genetic match doesn't have to be as close for the stem cells to be used. "The reason that people might store their own child's cord blood for their family would be if there's already a family member who has cancer or another disease that might be treated by a transplant, or because there may be uses in the future that will be valuable for things like tissue repair or tissue regeneration [3].

Steps Involved In Cord Blood Banking Collection

The care of mother or child should not be affected by collection of cord blood and there should be no significant deviation from normal procedures. If the process is initiated within ten minutes of the birth of the infant, the collections of cord blood are generally more successful.

Labeling of cord blood

At the completion of collection, the primary collection container should bear, at least, sufficient identification information to identify the product, the source and destination, the donor and recipient (if known), the conditions that are recommended for storage and transportation, and product characteristics such as anticoagulant used.

Processing and storage methods

Processing

Cord blood processing should commence within 48 hours of collection. Cord blood storage temperature pre-processing, should be maintained at between 1°C and ambient temperature, depending on methods used.

Storage vessels

Cord blood should be collected and stored in bags, vials, or other containers that are approved for cryopreservation of hematopoietic progenitor cells or should be validated by the cord blood bank to maintain viability.

Separation methods

Separation methods should be approved and described in written and demonstrated to be free from bacterial contamination. Methods should also be approved by the institutional review board or be well-described in the medical literature.

Sterility testing

As a component of quality control for the procedure, sterility testing for bacterial and fungal contamination should be done on a sample collected after addition of the cryo-protectant mixture and the results should be evaluated. Testing of a sample of the cord blood may also be performed at the time of collection.

Cryopreservation: Cryopreservation of the cells should be done by methods detailed in written procedures using the reagents that are approved for human use. Methods used should be well described in the medical literature or should be approved by an institutional review board. There should be non-human animal colloids.

Storage temperature

After processing, the storing of the cells should be within a temperature range of minus 196°C to minus 80°C. If the storage period is more than one year, then the cells should be stored at a temperature of less than -130°C. To store the cells continuously either a mechanical freezer is used or liquid nitrogen tank that is equipped with an audible alarm.

Final Labeling

The final product container must be labeled and/or tagged in correspondence with Department of Health regulations for labeling the

hematopoietic progenitor cells. The label should be distinct, memorable and should contain the donor's identification code.

Diseases Treated Using Cord Blood Stem Cells

Individuals with certain illnesses are treated with chemotherapy and/or radiation that destroy their own stem cells. Following this treatment, they receive a stem cell transplant, usually through a large vein in the chest. The transplanted stem cells make their way to the bone marrow. In the marrow, the stem cells continually make new copies of them and produce blood cells that rebuild a healthy blood and immune system. Transplanted stem cells can come from donated bone marrow (often called a bone-marrow transplant) or peripheral (circulating) blood, as well as from cord blood. In some cases, a person may receive a transplant of his or her own stem cells. Stem-cell transplants is a process that can be lifesaving for people suffering from leukemia (cancer of the white blood cells) and other types of cancers, or for people with serious blood disorders, such as aplastic anemia, in which the body does not produce enough blood cells. Cord blood is now the most common source of stem cells for children requiring a stem cell transplant. Donated bone marrow is the most common source for adults. However, cord blood is increasingly used in adults as well.

Blood related disorders, such as leukemia, thalassemia (also known as haemo-globinopathies) and sickle cell anemia.

Immune system disorders.

Emerging Treatments like, Diabetes, Cerebral Palsy, Brain Injury.

Metabolic disorders, such as Hurler syndrome (inherited condition that is caused by an enzyme deficiency). Some scientists have claimed that cord blood could potentially be used for curing diseases such as Alzheimer's, Parkinson's and conditions such as diabetes. Cord blood could be used to treat diseases that affect the brain, heart and spine is also claimed by the scientists. Other scientists argue that there is shortage of evidence to support these claims. It may be that in the future more diseases will be treated with cord blood. Presently, however, there is much more need for the research in this aspect to be done.

Help to Cure Cancer, Umbilical cord blood contains stem cells that do not have to be harvested from fetuses. These cells can be used to cure several diseases including leukemia.

Ethical Use of Umbilical Cord Blood Stem Cells

The umbilical cord blood stem cells collection and storage is completely ethical. There has been a lot of public debate recently, on the collection of other types of stem cells; these cells are collected from the aborted fetuses or human embryos that are grown in a lab. This debate does not include stem cells taken from umbilical cord blood of Adults or Non-Embryonic Stem Cells.

Pros and Cons of Cord Blood

Scientists have given evidence that the umbilical cord contains blood that is enriched with hematopoietic (blood-forming) stem cells. These cells may be used to cure genetic diseases, blood disorders, and

certain cancers. Transplants performed with cord blood have various advantages when compared to other types of transplants. Stem cells from the cord blood are expected to match with a wider variety of patients, and not as bone marrow transplant in which there is a need for more specific match. Moreover, research has shown that the average time to find a compatible match with a cord blood is much shorter than that with a bone marrow transplant. Another advantage is the noninvasiveness of the procedure. While, in bone marrow transplants there may be some pain to the donor. Cord blood allows easy access to the stem cells with no pain to the mother or the newborn.

A disadvantage of cord blood transplants when compared to bone marrow transplants is that the patient takes longer to recover. However, there are same healing effects as bone marrow stem cells even in cord blood stem cells. Another disadvantage of cord blood transplants is the reduced concentration of stem cells in it. Most adults will require at least 2 units of cord blood in order to experience the full healing effect.

Problems and Abnormalities

A number of abnormalities can affect the umbilical cord that can cause problems which affect both mother and child

[Umbilical cord compression](#) can result from conditions like entanglement of the cord, a knot in the cord, or a [nuchal cord](#), (in this the umbilical cord gets wrapped around the neck of the fetus) but these conditions do not always cause obstruction of fetal circulation.

[Umbilical cord prolapse](#)

[Vasa praevia](#) (obstetric complication in which fetal blood vessels cross internal orifice of the uterus)

[Single umbilical artery](#)

[Velamentous cord insertion](#) (umbilical cord getting inserted into the fetal membranes).

Umbilical Nonseverance

Some parents choose to omit cord breaking entirely, which is a practice that is known as "[lotus birth](#)" or umbilical nonseverance. In this process they allow the entire intact umbilical cord to get dried like a sinew, which then gets separated naturally (typically on the 3rd day after birth), falling off and leaving a healed umbilicus.

Umbilical Cord Catheterization

It can be used as a route for placement of a venous catheter for infusion and medication as the umbilical vein is directly connected to the central circulation. For the percutaneous peripheral or central venous catheters or intraosseous cannulas the umbilical vein catheter is a reliable alternative.

Cord Disposal

It is known that in some animals, the mother will consume the cord, thus separating the placenta from the offspring. It (along with the placenta) is usually eaten away by the mother, to provide nourishment and to dispose of the tissues that would attract the scavengers or predators. In [chimpanzees](#), the mother gives no attention on umbilical severance, instead nursing her baby with the cord, placenta, and all, until the cord

dries and separates by itself within a day of birth, at this time the cord is discarded ^[4, 5].

Advantages of Stem Cells from Cord Blood

Safe, easy collection

Collecting stem cells from cord blood poses no risk to mother or baby. Individuals who donate bone marrow must undergo a surgical procedure with general or spinal anesthesia. They may experience postoperative pain, and have a small risk of serious complications. Individuals who donate stem cells from blood must undergo several injections (shots) that stimulate release of stem cells into blood, occasionally causing bone pain and serious complications.

More Matches

For a bone-marrow transplant to succeed there should be a mostly perfect match of few tissue proteins (called human leukocyte antigens or HLAs) between the donor and the recipient. Family members, such as siblings, are most likely to be a tissue match. However, only about 30% of individuals who require a stem-cell transplant have a relative that is an appropriate tissue match. When stem cells of the cord blood are used, the cells of the donor appear more likely to "take" or engraft, even when there are partial tissue mismatches. This means that more individuals may be able to find an appropriate match using cord blood.

Faster Availability

Many individuals who do not have an appropriately matched family member can find a matched donor through national bone-marrow and cord-blood registries. It often takes at least two months to locate an appropriate bone-marrow donor compared to about two weeks for a cord-blood unit. The banked cord-blood cells also are available almost immediately. This can be crucial for patients with severe disorders who might die before an appropriate bone marrow donor can be found and complete the donation process.

More ethnic diversity

It is more difficult for the members of non-white ethnic and racial groups to find a match through a bone-marrow registry because there are fewer registered potential donors from non-white groups. The increasing use of cord-blood cells may make timely treatment available for more of these individuals.

Reduced risk of graft vs. host disease (GVHD)

In this complication, the donor cells attack the recipient's tissues. As the cord-blood cells are immature and may lack the ability to attack the recipient this appears to occur less frequently with cord blood than with bone marrow. A study said that a cord-blood transplant that the children received from a closely matched sibling were 59% less likely to develop GVHD than children receiving a bone marrow transplant from a closely matched sibling.

Fewer infections

Cord blood is less likely to contain viruses that can pose a risk to transplant recipients ^[6].

CONCLUSION

India has great potential for UCB banking due to a high birth rate and genetic diversity. Nearly

70 per cent of patients of Indian origin who require bone marrow transplantation do not find a match within their own family. Hence umbilical cord blood banks are widely accepted source for hematopoietic stem cell transplantation. However, total number of UCB transplants performed in India has been very low mainly due to high cost and lack of awareness too.

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